What is Collision Theory?

Worksheet

Collision theory: molecules must collide with kinetic energy activation energy (Ea) and correct orientation to react. Rate = (collision frequency) (orientation factor) (fraction with E Ea).

$$@text{rate} = A e^{-E_a/RT}$$

Questions

1. A collision has high kinetic energy but wrong orientation. Will it react?

A) Yes, always
B) No, orientation matters
C) Only at high T
D) Only with catalyst

2. Activation energy Ea represents

A) Total energy released
B) Minimum energy to react
C) Average collision energy
D) Thermal energy

3. If Ea is very large, the reaction is

A) Very fast
B) Very slow
C) Independent of temperature
D) Always exothermic

4. A 10C rise typically increases reaction rate by

A) 2-4
B) 10
C) 100
D) Negligible

5. A reaction has Ea = 50 kJ/mol and A = 1e13 s^-1. At 298 K, what is k? (Assume Arrhenius equation)

6. At what temperature will k double if Ea = 60 kJ/mol and A stays constant?

7. A collision has frequency Z = 1e34 collisions/s and only 0.01% have E Ea. How many react per second?

8. Define: What is collision theory?

9. Define: What is activation energy (Ea)?

10. Define: What is the pre-exponential factor (A)?

Answer Key

1. B) No, orientation matters - Both energy AND orientation are needed; collision theory requires both.

2. B) Minimum energy to react - Ea is the energy threshold; only collisions with E Ea can react.

3. B) Very slow - Large Ea means few molecules have enough energy; few collisions succeed.

4. A) 2-4 - Rule of thumb: ~2-3 rate increase per 10 K (depends on Ea and T).

5. k = A e^(-Ea/RT) k = 1e13 e^(-50000/(8.314298)) k = 1e13 e^(-20.16) k = 1e13 1.97e-9 20000 s^-1

6. ln(k2/k1) = Ea/R (1/T1 - 1/T2) ln(2) 60000/8.314 (1/298 - 1/T2) 0.693 = 7,217 (0.00336 - 1/T2) Solving: T2 310 K (rough ~37C rise)

7. Reacting collisions = Z fraction with E Ea = 1e34 0.0001 = 1e30 collisions/s reaction rate per mole 1e30/6.022e23 1,660 mol/Ls

8. Molecules must collide with energy Ea and correct orientation to react; rate depends on collision frequency and energy distribution.

9. Minimum kinetic energy required for a collision to result in a reaction.

10. Combines collision frequency and orientation factor; units depend on reaction order.